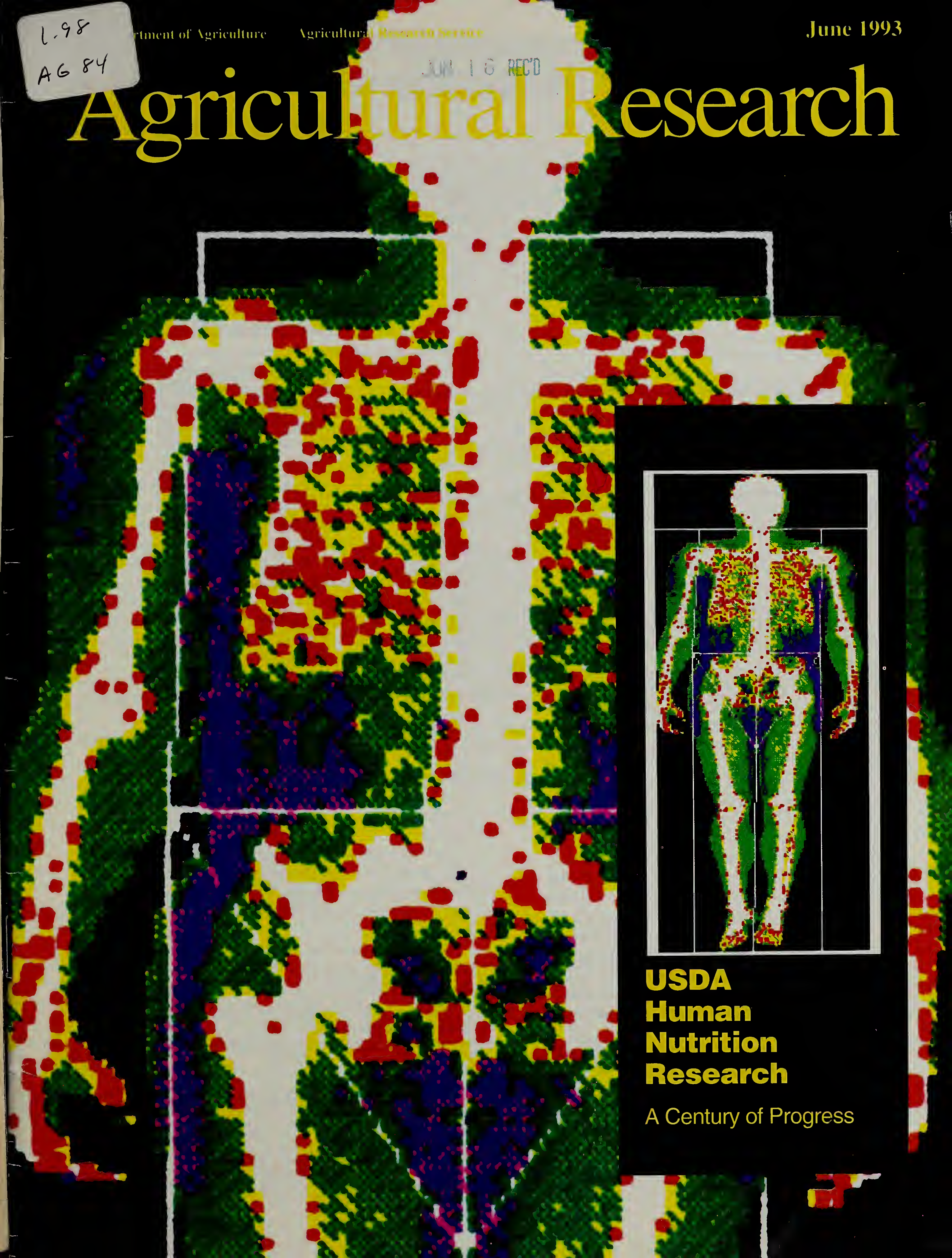
[...]rtment of Agriculture Agricultural Research Service

June 1993

Agricultural Research



USDA Human Nutrition Research

A Century of Progress

Atwater's Vision Still Guides Us

Next year will mark 100 years since the U.S. Department of Agriculture allocated the first funds for human nutrition studies.

Inspired by the untiring efforts of Wilbur Olin Atwater and to celebrate the centennial, USDA is sponsoring a symposium this month to evaluate its activities in human nutrition. It is useful to look back at the forces that drove nutrition research in the past to prepare for the future.

Americans are fortunate to have had Atwater direct the nation's first steps in nutrition research, education, and food assistance. His visionary concepts of the nutritional basis for health and well-being can be compared in their timelessness to the precepts of human rights put forth in the U.S. Constitution. Both still apply to the problems of today.

After Atwater, Charles Langworthy oversaw USDA human nutrition research and education programs until 1923. He was followed by a line of women leaders—Louise Stanley, Hazel Stiebeling, Callie Mae Coons, Ruth Leverton, and Faith Clark—who advanced Atwater's broad-based approach.

Thanks to the programs Atwater instituted, USDA was able to develop food budgets during the Great Depression to guide Americans in purchasing foods that would provide adequate nutrition on very limited incomes. And by the end of the 1930's, deficiency diseases such as rickets and pellagra were diminishing as science discovered essential vitamins and minerals, and education and food fortification enabled people to select adequate diets.

World War II shifted the research emphasis from nutrient scarcity to dealing with food scarcity through rationing and distribution. America not only fed itself and its troops abroad, but also helped keep war-ravaged Europeans from starving.

The first RDA's (recommended dietary allowances) were developed during the war to help policymakers in food distribution ensure adequate nutrition for all people.

By the 1950's, food was plentiful and cheap, leading to an era of overconsumption diseases. The focus of nutrition research switched from vitamins and minerals back to the macronutrients—fats, sugars, complex carbohydrates, and proteins—and the roles they play in promoting or protecting against heart disease, diabetes, and cancer.

Today, nutrition research is driven by genetics—an appreciation for the broad biological diversity among people in how they respond to food constituents.

For example, the majority of people do not develop high blood pressure from adding salt to their foods, and only half the population develops high serum cholesterol from the high-fat, Western-style diet. Obesity is another example: Some people are less efficient at metabolizing calories than others, based on their genetic makeup.

People's responses to these and many other food constituents are controlled by groups of genes, allowing for a wide range of variation. In research, we average the data from human subjects in order to apply statistics. But no one person is exactly the average. Testing early in life could pinpoint those individuals at high risk for one or more of the diseases of overconsumption who need to adapt their diets to reduce risk and postpone the disease.

Nutritionists have always recognized this diversity. In the 1939 Yearbook of Agriculture, Louise Stanley wrote: "Man is the combined product of inheritance and environment. Food is the environmental factor that most directly controls physical development; and it probably plays an important part in setting the pattern of nervous and emotional responses that make up the total personality."

The challenge for the 21st century will be to understand this interplay between our genes and food constituents on a far broader scale than we do now. Recommended intakes have been established for a few dozen constituents. But there are hundreds—perhaps thousands—that are active in the body. For instance, foods contain some 600 carotenoids, and we probably have the genetic capacity to use different ones interchangeably as antioxidants or detoxifiers. And nutrients will continue to be identified that could likely form a new class of "vitalimins"—a term derived from Latin words meaning factors for life nourishment.

Understanding the versatility of our genes will allow nutritionists to better advise people what to eat and what food substitutions can be made.

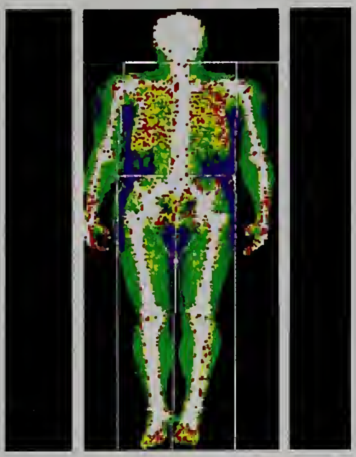
Until recently, nutrition science has not had the tools to track the countless interactions between genetics and diets. Now, we can turn to the new science of *complexity* to better understand them. In his book on the subject, Roger Lewin points out that "complex dynamic systems—including biological systems—often generate order."

This order is embodied in human nutrition. Fortunately, our cells have long known what our minds are just discovering. If we had to think of all the decisions our cells have to make in the span of a few microseconds, we would never have gotten past the one-cell stage.

In the past, nutrition has necessarily been studied in parts—as chemistry, biochemistry, physiology, cell biology, anthropology, and other disciplines. But it is all of these and more. The leaders of nutrition science have always understood and accepted this complexity as exemplified by Atwater's genius: He melded all the specialized disciplines into the whole science.

Jacqueline Dupont
ARS National Program Leader for Human Nutrition

Agricultural Research



Cover: Total body composition scan of a young adult male using DEXA (dual energy x-ray absorptiometry) to measure body energy stores. The colors reflect a range from soft tissue to bone. Courtesy of the Beltsville Human Nutrition Research Center. (K5138-1)

Page 14

Page 16

Page 17

Vol. 41, No. 6
June 1993

Editor: Lloyd McLaughlin	(301) 344-2514
Associate Editor: Linda McElreath	(301) 344-2536
Art Director: William Johnson	(301) 344-2561
Contributing Editor: Jeanne Wiggen	(301) 344-2502
Photo Editor: John Kucharski	(301) 344-2900
Assoc. Photo Editor: Anita Daniels	(301) 344-2956

Agricultural Research is published monthly by the Agricultural Research Service, U.S. Department of Agriculture, Washington, DC 20250-2350.

The Secretary of Agriculture has determined that publication of this periodical is necessary in the transaction of public business required by law.

Subscription requests should be placed with New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. Please see back cover for order form.

This publication was printed with soybean oil-based inks.

When writing to request address changes or deletions, please include a recent address label.

Address magazine inquiries or comments to:
The Editor, Information Staff, Room 408, 6303 Ivy Lane, Greenbelt, MD 20770

Mike Espy, Secretary
U.S. Department of Agriculture

R.D. Plowman, Administrator
Agricultural Research Service

Robert W. Norton, Director
Information Staff

Wilbur O. Atwater

Father of American Nutrition Science

Incredible persistence, prompted by a far-reaching vision of the importance of food in improving the human condition, earned W.O. Atwater his place in history.

In early 1893, the odds that Wilbur Olin Atwater would get public support for his grand plan for food investigations were slim to none. In fact, the future of the Office of Experiment Stations, which he had worked so hard to establish, was in doubt. But as often happens to people of vision, an "angel" interceded—in the form of a close personal friend of the Secretary of Agriculture who knew and admired Atwater.

On May 23, the Secretary wrote: "Mr. Edward Atkinson of Boston suggests the expediency of establishing food laboratories . . . ."

With those simple words, the door was pried open for the first federal funding of human nutrition research in the United States. Although it took another year of intensive skirmishing and skillful diplomacy, Atwater's efforts paid off. In May 1894, the agricultural appropriations bill included $10,000 for food investigations.

Today, we take for granted federal funding of nutrition research. In fact, in FY 1992, federal support of all U.S. Department of Agriculture activities in human nutrition research was about $82 million; nearly $200 million was spent on nutrition education and information programs.

And these figures do not include nutrition programs in other federal departments such as Health and Human Services. But in the 1890's, nutrition studies were quite new in the United States, and most of them were being done by Atwater himself.

"It is scarcely 50 years since the classical researches of Liebig [the renowned German chemist] began to pave the way for finding practically everything we know today of the ingredients of our food materials, the way in which they are used in the body, and the kinds and combinations which are best adapted to health and purse. Nearly all of the best experimental inquiry in these lines has been carried on in Europe," wrote A.C. True in introducing the first of Atwater's landmark publications, Bulletin No. 21, shortly after the new funding was granted.

Knowledge of the nutrients and their functions was very limited. Carbohydrates and fat provided energy to maintain body temperature and do muscular work. Protein had the added duty of building and repairing tissues. Vitamins were unknown. And only a few major minerals, such as calcium and phosphorus, were recognized as somehow essential, but their role in the body was unclear.

Atwater's quest for a scientific understanding of nutrition was coupled with the social consciousness of the day. In a 1894 letter, he wrote: "The individual man is coming to realize that

To find out how much food people needed to eat, Atwater surveyed the dietary habits of many population groups and measured the energy used by individuals engaged in workplace and household tasks.

1869	1875	1879
First analysis of a food or feed in the United States.	Named first director of the first U.S. experiment station at Wesleyan University, Middletown, Connecticut, 1875-77.	First to conduct extensive studies of human food—1879 to 1882—for the U.S. Fish Commission and the Smithsonian Institution.

he is his brother's keeper, and that his brother is not only of his household but may live on the other side of the world. With all these thoughtful people the conviction is growing that there is one fundamental condition of the intellectual and moral elevation of the poor, the ignorant, the weak, the destitute, namely the improvement of their physical condition."

Atwater joined the thinkers of the day in the conviction ". . .that the intellectual and moral condition and progress of men and women is largely regulated by their plane of living; that the plane of their intellectual and moral life depends upon how they are housed and clothed and fed."

A Man of Action

The son of a Methodist minister, Atwater was born in Upstate New York on May 3, 1844, but was reared in Vermont. He attended the University of Vermont for 2 years and graduated from Wesleyan University in Middletown, Connecticut.

After a short period as a schoolteacher and principal, he entered Yale University's Sheffield Scientific School, where his interest in agricultural chemistry was kindled. For his doctoral thesis, Atwater made the first modern analysis of a food—in this case, feed corn—in the United States.

With the ink still fresh on his doctorate, he set out for Leipzig and Berlin to study physiological chemistry with the masters. During his 2 years abroad, he became familiar with European agricultural experiment stations. This spurred him to campaign actively for a similar scientific program in the United States.

Two years after returning home, he found his way back to his alma mater and remained at Wesleyan University until his death in 1907. But he didn't teach much at Wesleyan; research was his love. Atwater's son recalled that his

Ergometer used to measure energy expenditure in calorimeter studies (about 1905).

father was threatened with having his salary cut in half "if he persisted in outside experiments. . . ." However, he was given the alternative of hiring a teaching assistant at his own expense—which he did.

One experiment Atwater did not plan occurred accidentally while he was in Paris in early 1893, and it illustrates his equanimity. He related the episode to his close friend and colleague C.D. Woods back in Middletown:

"You know I have long wanted to know the action of ptomaines from the flesh of fish. In accordance with my usual theory that the best way to learn is by practical experiment, I have been eating fish with the ptomaines—at least that is what the doctor says.

"Literally from the crown of my head to the sole of my feet I have been covered with swelling and blotches, feel as big as an ox, have a color approaching that of beefsteak, and a variety of aches and bruises which have left me with no lack of entertainment. . . . I think this one experiment will suffice of the demonstration."

Volunteer prepares to eat lunch in a respiration calorimeter (about 1915).

1886	1887	1887
Collaborated on the first accurate study of the chemical and economical statistics of food consumption with Col. Carroll D. Wright, chief of the Massachusetts Bureau of Statistics of Labor.	Lobbied vigorously for passage of the Hatch Act of 1887 establishing federal support of state experiment stations.	First director of a permanent experiment station at Storrs, Connecticut, 1887-1901.

Even under duress, Atwater showed good humor, though quite dismayed that the illness "took ten precious days out of my working time." He was a man of action.

As a special agent for USDA, he scouted top European laboratories and solicited articles and abstracts from the foremost researchers in agricultural and human nutrition studies. These would be translated and printed in the Experiment Station Record, one of three periodicals Atwater began as director of USDA's Office of Experiment Stations.

With utmost courtesy, Atwater badgered the European heavyweights for articles, abstracts, and answers. He wanted "to lift the Record and Bulletins to a higher scientific level," he wrote to a USDA contact. These publications were intended to inform researchers in the fledgling stations about the state of physiological research and guide them in designing their own studies.

But Atwater was aiming even higher. "My opinion," he noted, "is that we are in a fair way to make the Record and Bulletins the best publications of their kind in any language, and that if we keep on improving they will come to be recognized as such."

His leadership had been a major factor in getting Congress to provide $15,000 annually to each state and territory for the support of agricultural experiment stations. In fact, Atwater served as the first director of the new Office of Experiment Stations, on the condition that he could continue his research as professor at Wesleyan and director of the state station at Storrs, Connecticut.

When the workload grew to require full-time management in 1891, Atwater resigned his position—but not his mission. In fact, his life's calling was just beginning to crystallize. He began formulating plans for comprehensive studies of the chemical composition of foods, the effects of cooking and processing on nutrient content, the amount and types of food consumed by different groups of Americans, and the amount of energy (calories) people burned each day and thus needed to replace. He focused on soliciting funds to support this research. After all, these were uncharted waters, and there was no guarantee that USDA would come through.

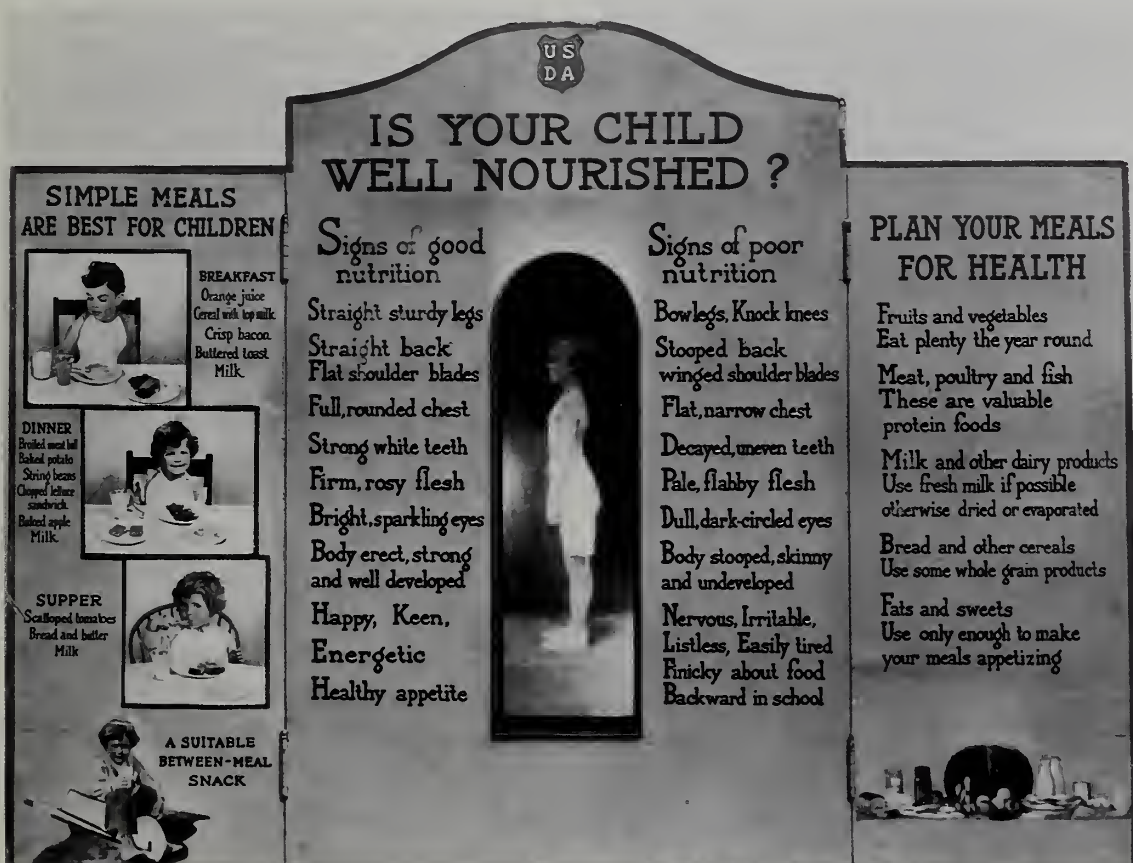
So Atwater "talked nutrition to church groups, businessmen's clubs, wealthy potential patrons, and government officials," notes Ross A. Gortner, Jr., a successor of Atwater's at Wesleyan University. "On many occasions, he financed the purchase of new equipment out of his own pocket. His staff, too, shared his enthusiasm and at times carried on their share of the work knowing that there might not be funds to cover their salaries."

Atwater even succumbed to showmanship. In October 1893, at the Chicago World Fair, he assembled 16 chemists who prepared and analyzed food before wide-eyed onlookers. The demonstrations stirred public interest and no doubt gave nutrition research a big push.

Atwater's most persistent trait was persistence itself. He did not become the father of American nutrition on intellect, charm, and vision alone. He simply never gave up.

In the 10 years that Atwater headed the federal nutrition program, he conducted or coordinated research in four areas:

- Types and amounts of foods consumed by different groups.
- Chemical composition of foods.
- Effects of cooking and food processing on nutritional quality.
- Amounts and types of nutrients people need to function at their best.



USDA Human Nutrition exhibit (about 1927).

Living in the midst of abundance, our diet has not been regulated by the restraints which obtain with the great majority of people (of Europe], where food is dear and incomes are small.—W.O. Atwater, 1894

this entailed studies of human metabolism and respiration.

The fact that these four research areas are still pursued actively today is testimony to Atwater's vision. He could not have imagined the scale or scope of today's research, but he would have applauded the emphasis on maintaining health through a good diet. The following sampling of today's research at the five human nutrition research centers under USDA's Agricultural Research Service attempts to bridge the gap between then and now.

Atwater oversaw more than 300 food consumption studies of families and institutions in 17 states, involving more than 10,000 men, women, and children. These included students, college athletes, the families of professional men, mechanics, farmers, and laborers, in widely separated states and of diverse ethnic groups.

Concerned about the nutrition of the poor and disadvantaged, Atwater supervised intake studies of black sharecroppers, Mexican families, poor whites, and inmates in state mental institutions. His observations ring true even today: "The differences in diet. . . are influenced, to some extent, by race habits, and to a still larger extent, by the material conditions of the consumer. . .especially the income."

Then and Now

Atwater left no stone unturned in gathering data on the eating habits of people worldwide. He scoured the European literature, wrote to missionaries in India, and cited studies of Chinese living on the U.S. Pacific coast, among others.

But the data he collated would pale beside the hundreds of intake studies done today, ranging from surveys of small population subgroups to those of national scope. Unlike the earlier surveys, today's studies are based on scientific samplings that accurately reflect the populations under scrutiny.

USDA's Human Nutrition Information Service (HNIS) and the Department of Health and Human Service's National Center for Health Statistics are the two federal agencies responsible for conducting the major national surveys. Happily, the two agencies are located side-by-side in Hyattsville, Maryland.

ARS, while rarely involved in population surveys, develops or improves tools used in collecting and analyzing such data. For example, researchers at the Western Human Nutrition Research Center in San Francisco have automated the record-keeping for smaller surveys.

Volunteers need only enter bar codes of the food they eat and weigh the portions. A laptop computer connected to the scale computes and stores the data for later evaluation.

Studies done with NESSY—the Nutrition Evaluation Scale SYstem—show it doesn't cause people to eat less than they normally would. That's been a problem before, when people are asked to write down everything that passes through their lips.

All five ARS centers develop or improve methods to assess people's nutritional status, particularly by noninvasive means. But it is a major emphasis at the Western center. Scientists there focus on marginal vitamin and mineral deficiencies—which are much more common than severe malnutrition in this country—and also on the consequences of excess intakes.

More than a decade ago, the Human Nutrition Research Center on Aging at Tufts in Boston was launched to study the role of nutrition in keeping people healthy well into old age. One of the first orders of business was to get a

BRUCE FRITZ

As part of studies on human dietary requirements for copper, chemist Phyllis Johnson, formerly at the Grand Forks Human Nutrition Research Center, analyzes the amount of copper absorbed from food eaten by volunteers. (K1794-6)

TIM MCCABE

At the Western Human Nutrition Research Center, nutritionist Mary Kretsch (left) instructs a dietary study volunteer in the operation of a computerized food scale. (K2658-1)

nutritional profile of the over-60 population.

Center scientists gathered data on the diets and nutritional status of nearly 700 people living on their own in the Boston area and of some 350 living in nursing homes. The eldest was 102. The survey provided much data on this rapidly growing segment of the U.S. population and has served to guide researchers to problem areas or unanswered questions.

In 1896, Atwater and Wesleyan graduate student A.P. Bryant published The Chemical Composition of American Food Materials—or simply, Bulletin No. 28. This bulletin would become the forerunner of USDA's Agriculture Handbook 8—the dietitian's bible. It listed the minimum, maximum, and average values of the known nutrients in all American foods analyzed by July 1895.

"Within 4 years, so many new analyses had appeared that a revised edition of the bulletin was issued," wrote Ross A. Gortner, Jr., who followed Atwater at Wesleyan University. "More than a third of all these analyses were performed by Atwater and his associates in the chemical laboratory at Wesleyan."

A 1906 reprinting of the bulletin, with only minor changes, stood until June of 1940 when USDA Circular No. 549 was published. Gortner noted, "I'm sure that [Atwater] could not have anticipated that it would not be superseded until some 40 years later. . . ."

The responsibility for maintaining and updating data on the composition of American foods now lies with the HNIS. Chemists at ARS' Human Nutrition Research Center in Beltsville, Maryland, work hand in hand with HNIS to develop faster, simpler, or more accurate analytical methods and to ensure quality control in the testing laboratories. For example, they have streamlined the official analytical methods for assessing dietary fiber as well as for cholesterol in mixed foods. And they have developed several food standards that testing laboratories use to check their procedures for accuracy.

Research is also being conducted on vitamins and other food constituents that appear to prevent heart disease or cancer, such as carotenoids and flavonoids. These two classes of compounds are abundant in many fruits and vegetables and give these foods their distinctive colors and flavors.

"The analytical sensitivity of many of the methods that are being used could not have been imagined by scientists during the time of Atwater," says Joseph T. Spence, director of the Beltsville center.

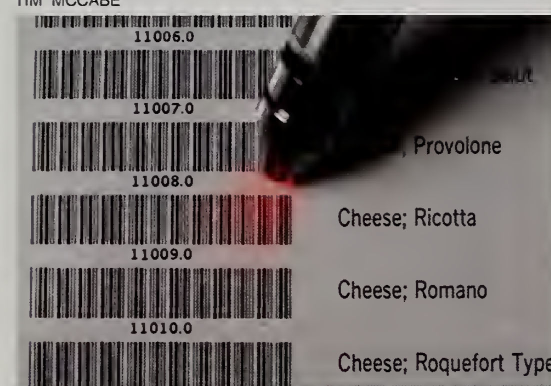
What Do Fresh Foods Lose?

Atwater also wanted to know how cooking and processing affected the nutritional quality of foods. He launched studies on nutrient losses during the boiling of vegetables, digestibility of breakfast cereals, changes incurred in the cooking of meats, and effects of milling and baking bread.

Because he was concerned only with fats, carbohydrates, and proteins, some of Atwater's conclusions are faulty today. For instance, he found that people absorbed more of these nutrients from bread when the flour was finely ground. So he concluded that milling wheat to retain a large proportion of the bran and germ decreased its nutritional value.

Today, we know that whole wheat flour contains vitamins, minerals, and fiber not found in white flour.

TIM MCCABE



A key component of the computerized food scale is a bar code reader that scans in the identity of each food weighed. (K2656-2)

This line of research is now largely in the hands of state universities, although a good deal is conducted by the food industry for its own use. ARS, on the other hand, is heavily involved in breeding crops having better balance and availability of nutrients, such as beta carotene or beta glucans, and meat animals with less fat or less saturated fat.

One ARS study, however, captured the news in 1992. It looked at the effects of trans fatty acids on blood cholesterol. These fats are formed when vegetable oils are hydrogenated to make margarine and many other products. The study showed that they have the potential to raise cholesterol and their place in the diet has become a matter of controversy. Now Beltsville researchers are working to define

Just what compounds in food are required for the nutriment of the brain, physiological chemistry has not yet told us; but it is certain that people with little muscular exercise require less food than those at hard muscular labor.—W.O. Atwater, 1894

the circumstances under which this might occur.

Just the Right Amount?

Most of the research done by ARS nutrition centers is about nutrient requirements. Knowledge of the types and amounts of nutrients we need to consume each day has grown exponentially since the days of Atwater. All of the vitamins and most of the minerals and trace elements known to date were discovered after his death in 1907. And other food constituents are proving their value against cancer, diabetes, or heart disease.

What's more, the emphasis is no longer on increasing human physical output or preventing deficiency diseases. Research today aims at enabling everyone to reach their optimum health, given the genes they are dealt at conception, and to maintain it as long as they live.

The best way to maintain good health throughout life is to get off to a good start. That's why the Children's Nutrition Research Center was begun in 1978 as a cooperative venture with Baylor College of Medicine and Texas Children's Hospital in Houston.

Most of the studies have dealt with infants, including the tiniest preemies, pregnant women, and nursing mothers. But research here is expanding to address energy and other nutrient requirements of children and the special needs of pregnant and nursing teenagers.

Houston researchers are finding that the proteins and fats in mother's milk do more than nourish the infant. Some of them signal the infant's immune and digestive systems to mature, as well as affect the infant's overall health.

This could explain why breast-fed infants took in one-fourth fewer calories and one-half less protein than formula-fed infants, yet gained and developed with greater efficiency, says center director Buford Nichols. He believes that "the search for these and other 'molecular messages' in the diet of infants and adults will continue to dominate nutrition research into the next century."

A substantial amount of the center's work goes into developing safe and noninvasive studies that can be done on infants, even those born before term. Researchers have perfected the use of stable isotopes—those nonradioactive variants of nature's elements. They can determine which amino acids an infant is synthesizing at a given time or how fast it is making its own cholesterol. These data will help nutritionists establish optimum diets for infants.

SCOTT BAUER

To investigate the effects of strength training on muscle and bone in older women, Miriam Nelson coaches volunteer Joan Caterino during a high-intensity workout. (K4610-12)

At the Western center, scientists are learning how adults can get a proper balance of nutrients when faced with the vast selection of foods in the marketplace—especially when health organizations and the federal government are recommending major changes in our diets. With only slight changes in food items, researchers were able to select diets containing 25 to 30 percent of calories from fat, much less cholesterol, and a higher ratio of polyunsaturated to saturated fat than in average contemporary diets.

The diets not only reduced serum cholesterol, says acting center director Judith R. Turnlund, they also had a dramatically higher vitamin and mineral content because of extra carbohydrates.

Studies at the Grand Forks [North Dakota] Human Nutrition Research Center over the past 20 years have resulted in the discovery of new trace elements—such as boron—as well as new functions for known ones. That's the main mission of the Grand Forks center, although the Western and Beltsville centers are also involved in trace element research.

But discovery is just the beginning. Researchers need to determine how much is essential, what foods supply the element, what factors interfere with or enhance the body's absorption or use of it, and more. What's more, they also study established trace elements that are consumed in only thousandths or millionths of a gram, to learn the consequences of marginal intakes.

For example, in studies at Grand Forks, boron is proving to play a role in maintaining healthy bones and optimal brain and motor function. And adequate intakes of two well-known trace elements—iron and zinc—have been found necessary for people to maintain body temperature in the cold, in addition to their established functions. [See *Agricultural Research*, October 1992, pp. 4-11.]

Researchers at all five centers are developing or improving methods for measuring body fat and lean tissue. Many Americans are overfed: A high fat-to-lean ratio is our biggest health hazard. It's especially serious in the elderly, because they lose lean tissue at a much faster rate than younger people.

The Boston center, established in 1980, operates under a contract between ARS and Tufts University. Researchers there are breaking new ground in learning the special needs of older people.

Recommended Dietary Allowances have been estimated largely from studies of younger adults because of the paucity of data on the aging population. In fact, the RDA's currently put all people over 50 into a single category. But an 80-year-old is no more like a 50-year-old than the latter is like a 20-year-old.

Center studies have shown that the loss of acid-secreting cells in the stomach—a common problem with aging—can interfere with absorption of vitamin B_{12} from food but not from supplements. It also appears that senior citizens need to consume more vitamin B_6 than currently recommended for their age group. And women past menopause need more vitamin D, as well as adequate calcium, to prevent osteoporosis.

TIM McCABE

Dietitians prepare meals for various studies with human volunteers at the Beltsville Human Nutrition Research Center. (K1992-9)

A good deal of research at the Boston center deals with antioxidants, such as vitamins C and E and beta carotene. If the process of aging that we once took for granted is due to cumulative damage by oxygen free radicals, then increasing antioxidants may help prevent it, theory holds. And studies suggest that antioxidant vitamins may delay cataracts or boost a flagging immune system.

The most promising news out of the center shows that declines in cardiovascular fitness and muscle strength are due to inactivity rather than aging. Elderly people can vastly improve both functions with the right exercises. There truly is no age limit on getting fit.

Atwater recognized his limited knowledge when he wrote in the 1894 USDA Yearbook of Agriculture: "Some foods have at times a great value outside of their use for nourishment. Fruits and garden vegetables often benefit people greatly not as mere nutriment. . . ." His words were prophetic: These foods provide a wealth of vitamins, minerals, and compounds like carotenoids; they also provide a lot of fiber.

And the concept of nutriment continues to grow.

Who knows how many food constituents—unknown or ignored—future research will show to have unsuspected effects on our metabolic processes? That's why it is so important to get our nutrients from a variety of fresh foods instead of relying on vitamin supplements to substitute for a poor diet. Look what we might be missing.—By **Judy McBride,** ARS, with contributions from nutrition research center directors **Buford Nichols, Forrest Nielsen, Joseph Spence,** and **Judith Turnlund.**

For more information, contact Jacqueline Dupont, USDA-ARS National Program Leader for Human Nutrition, Bldg. 005, 10300 Baltimore Ave., Beltsville, MD 20705-2350. Phone (301) 504-6216, fax (301) 504-6191. ◆

TIM McCABE

At the Human Nutrition Research Center on Aging, nutritionist Simin Meydani administers a skin test to see if vitamin E supplements boost the immune system in healthy older people. (K1940-13)

The Room Calorimeter

Atwater's "Copper Box" Revisited

The study of nutrition owes a great deal to the year W.O. Atwater spent in Carl Voit's lab in Germany. Voit's pioneering work focused on respiration—the exchange of gases between the blood and tissues—and calorimetry—the measurement of heat. It was Voit who had taken the first steps toward quantifying the human body's nutritional needs.

Atwater returned to America inspired. Before long he built a room calorimeter for human studies, as well as a bomb calorimeter for systematically measuring the energy values in foods themselves. The bomb calorimeter enabled Atwater to burn foods and products of excretion—human input and output, so to speak—making it possible to calculate the body's energy expenditure as the difference.

The room calorimeter revealed precise measurements about human energy expenditure. Early versions were slightly claustrophobic copper-lined chambers. In them, college students pedaled stationary bicycles, studied, and performed other physical and mental chores.

Just outside the little temperature-controlled room, Atwater and his associates were hard at work, keeping meticulous notes about the students' metabolism and recording the quantity of energy the volunteers expended on each task.

Atwater's calorimeter was capable of a precision almost unheard of in those days. When, in the middle of the night, a study volunteer happened to adjust his watch, the calorimeter duly indicated the sudden rise and fall in room temperature.

With accuracy like that, it's not surprising that Atwater's old mentors back in Europe pricked up their ears. Soon, eminent nutrition scientists like Carl Voit were factoring Atwater's baseline information into their experiments.

The famous Atwater 4, 9, 4 values were, until quite recently, linchpins in the study of nutrition. Atwater determined that one gram of carbohydrate yields 4 calories of energy, while fat yields 9 and protein 4, in a mixed diet.

Today, the room calorimeter continues to be a USDA research mainstay. Volunteers at the Human Nutrition Research Center in Beltsville, Maryland, lead comparatively normal lives inside the 9- by 10- by 8-foot chamber, eating, exercising, and resting. Meanwhile, as in the old days, scientists carefully monitor their bodily functions.

Inside an early respiration calorimeter.

The data generated with these volunteers may help researchers develop recommendations for diet and physical activity. Or it may trace the metabolism of individual nutrients, measuring the fat/lean composition of human bodies and assessing how people respond to differences in their diet, such as the proportion of fat.

Beltsville's room calorimeter uses two types of calorimetry: direct, which measures heat emission, and indirect, which calculates energy expenditure from measurements of oxygen consumption and carbon dioxide production. For accuracy's sake, the two methods can be checked against each other.

But not all calorimeters are room-sized. A tiny, specially modified indirect calorimeter at the ARS Children's Human Nutrition Research Center in Houston, Texas, accommodates the smallest of newborn babies.

While still in the hospital, these preterm infants have their first "volunteer" experience. They are placed in a full-body, custom-designed preemie calorimeter that resembles a newborn isolette. Every calorie of energy the newborns burn is recorded by researchers.

While in the calorimeter, babies continue to receive expert medical care without interruption.

Babies who have completed full terms of gestation and who are between 3 and 6 months of age are studied during sleeping periods. They snooze for short times under specially designed calorimeter hoods. Sound asleep, the infants enable scientists to estimate the comparative energy expenditures of full-term infants.

Pregnant women, including teenage mothers-to-be, participate in room calorimeter studies in Houston. They're helping scientists answer important questions such as:

- How many calories do normal, healthy pregnant women consume? What about teenage moms? Infants?
- How do nutritional factors contribute to a normal pregnancy?
- What would constitute proper RDA's for pregnant women?
- How do breast-fed babies metabolize nutrients? Does it differ from formula-fed infant patterns?
- What nutrients are lacking in baby formula?

By addressing such basic questions about human nutritional needs, calorimeter studies touch many lives, including those of America's poorest and most dependent citizens. Both

USDA's Food Stamp and WIC (Women and Infant Children) programs are predicated on a cogent understanding of human dietary needs—an understanding obtained from state-of-the-art scientific measurement and study.—By **Jeanne Wiggen,** ARS. ◆

ADAM GILLUM

▶ At the Children's Nutrition Research Center, nutritionist Nancy Butte prepares an infant for a short stay in a specially designed calorimeter. (93-3)

▼ Volunteer Valerie O'Brien exercises during her 24-hour stay in the room calorimeter, while biomedical engineer James Seale monitors her energy expenditure. (K5136-15)

SCOTT BAUER

Complex Interactions Frustrate Nutrition Researchers

"The more I study nutrient interactions, the more I realize how little we know about them," Meira Fields says in her delightful way as she throws up her hands in a gesture of surrender.

"People have to be aware that when we talk about nutrients we have to talk about interactions. We don't eat or drink carbohydrates, proteins, fat, alcohol, or supplements alone. We take them together," notes Fields.

And when our intakes are out of balance, it can throw the interactions out of balance.

The trace metals—such as iron, copper, or zinc—are particularly meddlesome. In the body, they are bound to proteins to keep them nontoxic, she says. "It could be that many of our metabolic diseases, including heart disease, are due to adverse interactions between metals and metabolites."

In her laboratory at the Beltsville Human Nutrition Research Center in the Maryland suburbs of Washington, D.C., Fields and colleagues Charles G. Lewis and Mark D. Lure have been developing a scorecard to rate the various factors that determine whether or not rats suffer organ damage and die young from eating copper-deficient diets.

Fields has established that a copper-deficient diet alone is not enough to damage the heart, liver, and pancreas of her test rats. They also have to be getting excess fructose or sucrose (table sugar) in their feed or have their drinking water spiked with alcohol. Rats, like people and other animals, metabolize fructose and alcohol via a similar biochemical pathway, she explains. And it differs from the pathway used in metabolizing glucose—the basic unit of all starches.

However, not all rats develop organ damage and die from a copper-deficient diet containing high levels of fructose or alcohol. Only the male rats suffer, and only if they get this diet very early.

"The females are somehow protected," Fields says, but she doesn't know how. She tested the theory that female hormones or reproductive organs were giving female rats the edge but found that animals whose reproductive organs are removed come through the dietary challenge quite well. So rats have to be young and male and consume lots of fructose or alcohol along with too little copper before they suffer lethal organ damage. Eliminate any one of these factors and the animals survive normally.

KEITH WELLER

In laboratory rats, pale eyes, feet, and tail and a rough, discolored coat are signs of copper deficiency to biochemist Meira Fields and nutritionist Charles Lewis. (K5104-1)

Although Americans eat less than a fourth of the fructose in Fields' experimental diets—which is 62 percent of total calories—U.S. consumption has been growing steadily. Fructose constitutes half of the sugar in table sugar and slightly more than half of the sugar in high-fructose corn sweeteners, which are used today in most processed foods and beverages—not just in the sweet ones. So it's virtually impossible for people to avoid fructose. The typical U.S. diet contains no more copper, on a pound-for-pound basis, than the rats got. However, it's difficult to compare human intakes with the rats' diet because these were rapidly growing baby rats who need more copper than an adult. And they breathed purified air and drank distilled water so their only source of copper was the feed.

Still, diets resembling U.S. intakes of fructose and copper have caused damage in pigs.

The damage in rats, according to Fields and colleagues, appears to be due to iron. That's right, iron. It's not so surprising, she says, because copper and iron are antagonist elements. Their common physical and chemical properties mean that they compete for the same metabolic sites.

She says one of the first symptoms in the male rats is anemia. It occurs even though all rats—males and females—store a lot more iron in their livers when their food is copper-deficient. And they do so regardless of whether they get excess fructose or not. "So something is

KEITH WELLER

Rich sources of copper: oysters, beef or lamb liver, Brazil nuts, blackstrap molasses, cocoa, and black pepper.

Good sources: lobster, nuts and sunflower seeds, green olives, and wheat bran. (K5106-1)

wrong with iron metabolism in the males that get fructose. They can't use what they have.

"The amount of iron is not important," she continues. "It's what form the iron is in. For example, if I want to make a call on a pay phone and don't have any change, all the dollar bills in the world won't help me. I need quarters!"

A collaborative study with William E. Antholine at the National Biomedical Electron Spin Resonance Center of the Medical College of Wisconsin in Milwaukee demonstrated that the livers of male rats on a copper-deficient, high-fructose diet did indeed seem to store dollar bills instead of quarters.

What's more, the unusable iron was in the form that prompts docile oxygen molecules to turn into destructive free radicals. These unstable oxygen molecules have a penchant for pulling electrons out of just about any biological molecule in their immediate vicinity and thus can damage cell membranes, proteins, even DNA.

If iron was the instigator, then reducing the amount of iron in the rats' bodies should reduce abnormalities, she reasoned. And that's exactly what happened.

Fields and colleagues tested two different methods to reduce iron levels in male rats. First, they fed the rats an iron-binding agent, deferoxamine, which is used in medical practice to remove excess iron in patients with iron overload. And because deferoxamine binds to iron, it also defuses the form that generates free radicals, preventing oxidation. In a second experiment, they cut the amount of iron in the rats' feed by two-thirds.

In both cases, she says, the anemia and damage to the heart and pancreas were prevented. They did not test the liver. The most dramatic effect: All the rats survived the study.

"All the pathology for copper deficiency can be prevented by making the diet iron deficient or by substituting starch for fructose," she says. The lesson here is that "under certain conditions, iron can be very toxic."

She strongly suspects that this toxic form of iron is responsible for the animals' liver and pancreatic damage but says she hasn't ruled out other causes. The heart damage, however, she attributes to the animals' anemia because Antholine saw no evidence of free radicals in their heart tissue.

Just recently, Fields found that the type of protein in the diet also plays a role in the severity of copper deficiency. In her experimental diets, she used one of three different proteins: lactalbumin or casein, both of which are milk proteins, or egg white. The male rats getting lactalbumin had the most abnormalities.

Fields notes that female rats on copper-deficient diets store even more iron in their livers than males but do not generate the free radicals that males do. She believes that men who consume a lot of sugar or drink alcohol regularly may be putting themselves at risk of iron toxicity if their diets are inadequate in copper. And the amount of copper needed by humans is still uncertain. "It's a cumulative problem," she stresses. "We're talking about long term in people.

"How do we know that other nutrients aren't involved in similar interactions?" she asks. "We don't, because no one has done the research!

"If researchers don't take adverse nutrient interactions seriously, we cannot progress in understanding what's behind metabolic diseases," she warns.

To ensure that interactions stay in balance, she recommends the same dietary habits grandmother urged on us: Eat everything in moderation, for a wide variety of foods ensures getting all the nutrients in the right proportions.—By **Judy McBride,** ARS.

Meira Fields is at the USDA-ARS Beltsville Human Nutrition Research Center, Bldg. 307, 10300 Baltimore Ave, Beltsville, MD 20705-2350. Phone (301) 504-9412, fax number (301) 504-9456. ◆

Discovering Plants' Master Genes

In every plant, genes orchestrate the fate of each cell. Genes determine, for instance, whether a cell will help form a new leaf, stem, or root.

But science hasn't yet discovered what genes are the key players in this process, known as cell differentiation. "If we knew which genes control a cell's fate, or how those genes work," says geneticist Sarah C. Hake, "we could change those genes and improve tomorrow's plants."

Hake's studies of corn plants have yielded an important new clue to solving the puzzle of how genes dictate a cell's future. In experiments at the ARS/University of California Plant Gene Expression Center at Albany, Hake discovered the first-ever homeobox in plants.

A homeobox is a region of a gene that enables it to control other genes crucial to a plant's final form and function. "A gene with a homeobox," says Hake, "may control a cascade of events in a plant's growth."

Hake's finding, reported in a cover article of the international scientific journal *Nature* in 1991, added plants to the list of organism—fruit flies, beetles, worms, mice, frogs, and humans, for instance—already known to contain influential homeobox regions.

BRUCE VEIT

Altered patterns of corn leaf development caused by the *Knotted* mutation. (93-5)

She found the plant homeobox in her investigations of *Knotted*, a mutation of a corn gene that changes the way leaves develop.

For the past 7 years, she has focused her research on *Knotted*, in part because the mutations are easy to detect.

JACK DYKINGA

Geneticist Sarah Hake examines varieties of corn before selecting kernels to plant. (K4554-5)

The mutations aren't of commercial value; they cause cells to differentiate abnormally so that leaves, instead of being smooth, have strange knots, bumps, or fingerlike projections.

Knotted's scientific appeal lies in what it can reveal about normal cell differentiation. Says Hake, "We can use *Knotted*, a gene that we at least partially understand, to give us clues to the activity of other genes that we don't understand—or that we want to know more about—such as those that control reproduction."

Hake and others have now used the *Knotted* homeobox as a probe to identify more than a dozen other homeobox genes in corn, plus some in tomatoes, barley, peas, and rice. The aspects of growth that these homeobox genes control, however, remain unknown.

"Hake's work is remarkable," says Gerald G. Still, director of the Plant Gene Expression Center. "It has not only pinpointed a region of a corn gene that may profoundly influence that plant's growth, but has also helped other scientists in their search for similar master genes in other crops."

The research, says Still, may provide new, unprecedented options for science to revise the architecture of crops in the next century.

Tall, slender corn plants, for example, might be replaced by thick, squat ones that outproduce even today's best hybrids. The same could happen with fruit or vegetable crops.

"This redesign would exceed anything that's currently possible with conventional breeding," says Still. He admits that these stocky, powerhouse plants are—for now—in the realm of science fiction. "But," he says, "they are definitely going to happen."—By **Marcia Wood,** ARS.

Sarah Hake is with the USDA-ARS/University of California Plant Gene Expression Center, 800 Buchanan St., Albany, CA 94710. Phone (510) 559-5900, fax number (510) 559-5678. ◆

Flightless Wasp a Step Ahead in Biocontrol

A quarter-inch-long wasp that can't fly could save the spring cotton crop from the ravages of the cotton bollworm, *Helicoverpa zea,* if future ARS field trials "fly."

"Our mutant version of the wasp, *Microplitis croceipes,* looks like a flying ant with its wings clipped in half. The fact that this wasp can't fly away from its attack site makes it worth rearing and releasing in the field," says ARS geneticist William W.M. Steiner.

"We hope to suppress the populations of these costly pests by releasing the mutant form of the moths' natural enemy—*M. croceipes*—into wild geraniums that surround cottonfields in Mississippi," says Steiner.

Microplitis croceipes **wasps—a proven biological control against the cotton bollworm—may become even more effective because wing mutations limit their ability to fly away from release sites. Specimen on right has normal wings. (93-4)**

Steiner and Yongsheng Li, a former graduate student and now a researcher at the University of Missouri, found the clipped-winged mutation after screening more than 10,000 wasps at ARS' Biological Control of Insects Research Laboratory in Columbia, Missouri.

The Missouri scientists are planning to isolate the gene responsible for the wasp's naturally clipped wings. Once that's done, they hope to move it into other biological control parasites. ARS technician Darrell Davis is making the crosses to assist in isolating the gene.

Researchers are looking for new biological controls to lessen the release of chemicals in the environment and because crop-damaging moths are rapidly adapting to survive existing chemical control methods.

Moths of the *Heliothis/Helicoverpa* complex—the cotton bollworm, tobacco budworm, corn earworm, and tomato budworm—cause hundreds of millions of dollars yearly in damage to more than 100 U.S. crops.

The first generation of bollworms develop on wild geraniums and in the adult stage begin moving into newly emerged cotton, and later on, into budding cotton.

Last year, the cotton bollworm caused total losses of about $331.4 million in cotton alone. This includes the cost of insecticides and the loss of crop value in the major cotton-producing states: Arizona, Arkansas, California, Mississippi, southeast Missouri, and Texas, according to Marion R. Bell, ARS entomologist in Stoneville, Mississippi.

Populations of mutant *M. croceipes* will be reared at Mississippi State University. In the early spring of 1994, the Missouri researchers and ARS scientists from the Southern Insect Management Laboratory in Stoneville will test the mutant wasps.

"Because this wasp can't escape the release site, its presence will place constant biological pressure on developing bollworms, thus reducing damage to the cotton. Their value as a biocontrol lies in the fact that they stay in place and don't attack any other insect," Steiner says.

If successful in field trials, mutant *M. croceipes* could also benefit home gardeners. Besides being flightless, this wasp also lacks venom. Its stinger is used strictly as an ovipositor to place the egg inside a host insect.

"This wasp's stinger isn't designed to puncture people," says Steiner.

In the meantime, the Missouri researchers are looking for other interesting wing mutations in *M. croceipes.* So far, they've found wasps with notched wings and some with no wings at all.—By **Linda Cooke,** ARS

William W. M. Steiner is at the USDA-ARS Biological Control of Insects Research Laboratory, Research Park, Route K, P.O. Box 7629, Columbia, MO 65205. Phone (314) 875-5361, fax number (314) 875-4261. Marion R. Bell is at the USDA-ARS Southern Insect Management Laboratory, P.O. Box 346, Stoneville, MS 38776. Phone (601) 686-2311, fax number (601) 686-5421. ◆

For Potatoes—Stopping Dry Rot Without Chemicals

Potato dry rot—a dry, crumbly decay of the potato tuber—may soon be controlled with a natural bacterial agent instead of a synthetic chemical.

"Dry rot is caused by a fungus, *Fusarium sambucinum*, that affects potatoes both in the field and in storage," explains David A. Schisler, a plant pathologist at the National Center for Agricultural Utilization Research in Peoria, Illinois. "The fungus enters potatoes through wounds in the skin. Losses due to this disease have been reported to be as high as 60 percent in storage."

Under proper conditions, potatoes are capable of healing their wounds within a few weeks following injury. But during this time, tubers are susceptible to infection, so scientists are searching for a microbial biological control that would be active throughout this period of vulnerability.

Schisler and Patricia Slininger, a chemical engineer at the center, have found bacteria that reduce the size of affected areas and, in some cases, totally prevent the disease.

The disease-fighting bacteria are from soil samples gathered in 1990 from Wisconsin potato fields. The scientists initially found 18 strains that showed promise as biological controls against dry rot. Since then, they've narrowed the field to six by evaluating strains for both effectiveness and ease of mass production.

Growers now use a chemical, thiabendazole (TBZ), to control the disease. It has been used for about 20 years and is the only fungicide approved for postharvest treatment of dry rot. However, recent studies indicate that 75 percent of field isolates of the fungus are completely resistant to TBZ.

"There's a control void here that microbial biological agents are well-suited to fill," says Schisler.

A patent application has been filed. Further work will involve development of liquid culture and formulation technologies needed to produce the bacteria as storable, effective biocontrol agents.

Explains Slininger, "The conditions applied during mass production of the bacteria in liquid culture will likely affect the physiology, vigor, and, hence, efficacy of the bacterial cells harvested."

To preserve cell viability and facilitate crop treatment, scientists are considering a wettable powder formulation of dried bacterial cells and a carrier. Such a product would be handled and applied much like the wettable powder fungicide currently in use.—By **Marcie Gerrietts**, ARS.

Dave Schisler and Pat Slininger are in the USDA-ARS Fermentation Biochemistry Unit at the National Center for Agricultural Utilization Research, 1815 N. University St., Peoria, IL 61604. Phone (309) 685-4011, fax number (309) 671-7065. ◆

Research Links Zinc, Vitamin A Status

Most of the schoolchildren in the poorest part of Thailand are getting vitamin and mineral supplements, thanks to cooperative research between ARS and Thai nutritionists. And thanks to these children, we now know that getting enough zinc by itself can correct some—but not all—of the consequences of a marginal vitamin A intake.

In 1987, Thai researcher Emorn Udomkesmalee spent a year as a visiting scientist in ARS' Vitamin and Mineral Nutrition Laboratory in Beltsville, Maryland. She analyzed hundreds of blood samples of grade-school-age children living in northeast Thailand to identify those low in both nutrients.

"These children survive on a poor diet of rice, small amounts of vegetables, and chili peppers," says Udomkesmalee. Her analyses showed that one out of four had blood levels of vitamin A and zinc well below normal. [See *Agricultural Research*, February 1988, p. 11.]

Earlier, James C. Smith, who heads the Beltsville lab, had found that zinc is needed for vitamin A to function normally. A zinc deficiency can cause an apparent vitamin A deficiency.

The theory, he says, has been corroborated in many subsequent studies. But no one had established whether or not zinc alone can correct some of the consequences of vitamin A deficiency, such as night blindness and a weakened immune response to infections.

So Smith, Beltsville immunologist Tim R. Kramer, Udomkesmalee, and other Thai researchers collaborated in a study of 140 Thai children, ages 6 to 13.

The children were given either placebos, zinc supplements, vitamin A supplements, or both zinc and vitamin A for 6 months. Compared with the placebo, zinc alone and zinc plus vitamin A improved the students' responses to functional eye tests, including their ability to see in dim light. But it took both zinc and vitamin A to raise their immunity to tuberculosis above that of the placebo-treated group, says Kramer.

The study helped alert Thai authorities to the public health problems, and they have responded by providing supplements for the children.—By **Judy McBride**, ARS.

James C. Smith and Tim R. Kramer are at the USDA-ARS Vitamin and Mineral Nutrition Laboratory, Bldg. 307, 10300 Baltimore Ave., Beltsville, MD 20705-2350. Phone (301) 504-8351/8459, fax number (301) 504-9062. ◆

Science Update

Wasps, Computers Used Against Cotton Pest

Tiny black Mexican wasps act as vigilant "foot patrols" in pursuit of boll weevils, so the wasps are being tried in expanded field tests this year. The female *Catolaccus grandis* wasp hunts for fallen cotton flower buds infested with immature weevils. She lays eggs in these buds, pausing to snack on some weevils. Within days, her offspring hatch and gobble up lots more weevils. ARS will release about 500,000 wasps in test fields in Texas and Alabama.

Meanwhile, Mississippi growers are snooping on weevils with the help of computers. Every 2 weeks, two-thirds of the state's cotton growers count the boll weevils caught in field traps. The Extension Service relays the data to an ARS lab. There, color-coded maps of weevil populations are made with an ARS-designed computerized geographic information system (GIS). Scientists, extension agents, and growers in the state are using GIS maps to plan the best weevil-control strategy for a given region. *Edgar G. King, K.R. Summy, and J.A. Morales-Ramos, Subtropical Agricultural Research Laboratory, Weslaco, Texas. Phone (210) 565-2423. James W. Smith and Glenn Wiygul, Boll Weevil Research Unit, Mississippi State, Mississippi. Phone (601) 323-2230.*

To Lose Calories, Better To Burn 'Em Than Spurn 'Em

When it comes to losing weight, keeping active may do more than keeping away from the cookie jar. In a recent ARS study, body-fat levels were unrelated to calorie intake in two groups of sedentary men—one in their 20's, the other over 65. But the most sedentary men had the most fat. The study supports earlier evidence that current Recommended Dietary Allowances for energy (calories) may be set too low for some populations. For example, the older men burned an average of 15 percent more calories than the 2,400-calorie RDA, even though they didn't exercise regularly. *Susan B. Roberts, Human Nutrition Research Center on Aging at Tufts, Boston, Massachusetts. Phone (617) 556-3238.*

DAVID NANCE

(K2976-18)

Kenaf Has Alfalfa Beat on Protein

Kenaf may be gaining on alfalfa as a high-protein livestock feed. From Kansas southward, bamboo-like kenaf could give winter-wheat farmers a second crop. Sixty to 80 days after planting in central Oklahoma, kenaf yielded 3 tons of dry leaves and stems per acre. Its leaves held 30 percent crude protein—compared with alfalfa's 16 to 21 percent. Later kenaf harvests weren't so protein-rich, but dry matter soared near 6 tons. If winter wheat is planted for grazing, kenaf can go in the same ground in May. If the wheat is harvested for grain, kenaf can be planted in late June. *William A. Phillips, Grazinglands Research, El Reno, Oklahoma. Phone (405) 262-5291.*

Licensee Named for Food and Water Bacterial Test

Dole Associates of Katonah, New York, has received a limited license to market an ARS-developed test to detect *Yersinia enterocolitica* in food and water. These bacteria can cause serious illness and even death in people. Unlike current tests, the new one doesn't kill the bacteria. That lets health officials later confirm their initial findings when they investigate possible *Y. enterocolitica* outbreaks. The Food and Drug Administration recently used the ARS technology to detect an outbreak in Los Angeles County, California. USDA's Food Safety and Inspection Service is training personnel to use the new test. *Saumya Bhaduri, Microbial Food Safety Research, Philadelphia, Pennsylvania. Phone (215) 233-6521.*

New Test Monitors Soy Oil Quality

Fat-like molecules called phospholipids can damage soybean oil's flavor and stability. Now, processors can easily adapt a new ARS technique to monitor the oil more closely. Normally removed during processing, phospholipids can be difficult to extract if they are formed during the beans' pre-harvest stress or later, during storage and shipping. Now, the new method uses reverse-phase high-performance liquid chromatography to detect and measure even very low amounts of phospholipids. *Timothy L. Mounts, National Center for Agricultural Utilization Research, Peoria, Illinois. Phone (309) 685-4011.*

U.S. Department of Agriculture
Agricultural Research Service
Room 408
6303 Ivy Lane
Greenbelt, MD 20770

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G-95

To stop mailing ______ ☐
To change your address ______ ☐
Please return the mailing label from this magazine.

Upcoming in the July Issue

- Scientists at the U.S. Grain Marketing Research Laboratory are developing technology for a "total quality grain marketing system" for American farmers.
- Bee disease diagnosticians in a special Maryland laboratory are the front line of defense for beekeepers worried about accidental invasion by new pests or diseases.
- Detecting and identifying elusive plant viruses and viroids in important crops and ornamentals is now easier with genetic engineering tools.